MONTLAKE BRIDGE **HAER No. WA-108**
(Montlake Avenue Bridge)
(Montlake-Stadium Bridge)
State Route 513 spanning the Lake Washington Ship Canal
Seattle
King County
Washington

HAER
WASH
17-SEAT,
14-

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

PHOTOGRAPHS

HISTORIC AMERICAN ENGINEERING RECORD
NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR
P.O. BOX 37127

HAER
WASH
17-SEAT,
14-

HISTORIC AMERICAN ENGINEERING RECORD

MONTLAKE BRIDGE
(Montlake Avenue Bridge)
(Montlake-Stadium Bridge)
HAER No. WA-108

Location:	State Route 513, spanning the Lake Washington Ship Canal, Seattle, King County, Washington, beginning at mile point 0.19. UTM: 10/552310/5277140 Quad: Seattle North, Washington
Date of Construction:	1925
Engineer:	Designed by the Seattle City Engineering Department. Advisory architects were Edgar Blair, Harlan Thomas, and A. H. Albertson.
Fabricator:	Contractors were C. L. Creelman, substructure, Wallace Equipment Company, superstructure, and Westinghouse Electric and Manufacturing Company, electrical equipment.
Owner:	Originally, City of Seattle. Presently, Washington State Department of Transportation.
Present Use:	Vehicular and pedestrian traffic.
Significance:	This bridge, a Seattle landmark, is one of six bascule bridges based on a design developed by the City of Seattle which was derived from the Chicago bascule bridge type. It is unique because of its trunnion supports, employed to avoid a patent infringement lawsuit by the Strauss Bascule Bridge Company, and its architectural treatment. The bridge has been placed on the National Register of Historic Places.
Historian:	Wm. Michael Lawrence, August 1993

History of the Bridge

The history of the Montlake bridge is inextricably intertwined with that of Seattle, with the city's controversial bascule bridge-building program of the second and third decades of the twentieth century, and with the development of bascule bridges throughout the United States. It has continued to play an important role in the life of the city as part of an important transportation route and as a landmark.

Seattle is a "city of bridges." It is built on a hilly strip of land between Puget Sound and Lake Washington. The canal joins the two water bodies, dividing the city. The Duwamish River enters the sound south of the commercial center. Harbor Island, at the mouth of the river, splits it into two channels. It is not surprising that at least 90 bridges and viaducts serve the city and its environs.[1] Seattle has several movable bridges. The Montlake bridge was the last of four to be built across the Lake Washington Ship Canal.

The canal was built to provide the city with additional harbor space in Lake Washington. In 1910 Congress authorized $2,275,000 for construction of locks for the canal. King County raised $1,055,000 for right-of-way and excavation. The Washington state government provided $2,051,000 in right-of-way through the University of Washington campus and for rights to lower Lake Washington. The city was to build the bridges over the new waterway.[2]

The city started planning a major bridge program to span the canal and the east and west branches of the Duwamish River. On 26 February 1913, the *Seattle Post-Intelligencer* reported that the city council, in extra session the previous day, voted to ask the Secretary of War for permits to build bridges at those sites. The issue was a controversial one, requiring 4 hours of debate during this meeting, "with a lobby of more than 300 citizens present." Councilman Albert J. Goddard proposed that subways or tunnels be built instead, an idea that drew little support. Paul H. Phillips, representing the Federated Improvement Clubs of West Seattle asked that a portion of the proposed bond issue of $1,600,000 be set aside for the Spokane Avenue bridges. Councilman Austin E. Griffiths favored delaying the decision until after 4 April, and then leaving it to the people in a referendum. There was also some debate over the exact locations of the bridges.

The city council decided on locations for eight bridges. These were to be from Westlake Avenue at Fremont Avenue, from Fifteenth Avenue northwest to Ballard Avenue, from Eastlake Avenue at Sixth Avenue northeast, at Spokane Avenue over the West Duwamish

Waterway, over the canal at the portage from Montlake Avenue to the university district, over the West Duwamish waterway at Spokane Avenue, over Third Avenue west to Fremont, over the Westlake Avenue to Stone Avenue, and over Third Avenue west to Fremont[3] The first six locations on the list closely correspond to the sites of six double-leaf bascule bridges built by the city during the following two decades.

On 23 October 1913 the council created a bridge fund, appropriating $25,000 from the garbage fund as seed money. This was to be the nucleus of a larger fund, consisting of money from the bond issue. It also directed the board of public works to begin test borings for piers and make estimates for construction costs.[4] At about this time, foundations were laid for one of the bridges, the Montlake, during the construction of the canal.[5] The bridge itself would not be built until 1925.

Bridging the canal was a sensitive issue, especially the western branch at the University of Washington. An article in the *Seattle Post-Intelligencer* dated 30 November 1913 discussed the Eastlake bridge, now known as the University bridge, to the northwest of the campus. Citizens were debating over whether it should be located at Sixth or Tenth Street. According to the author, a bridge at Tenth Street would be more convenient, facilitate growth north of the city's commercial district, and concluded that "Seattle has no asset of greater importance than our state university. . . . Seattle should encourage the workings of the university by making it convenient for all students, visitors and patrons to go to and from the campus promptly."[6] The article highlights the importance of this institution to the city of Seattle. Two of the bridges in Seattle's bascule bridge program would serve the campus, this one to the northwest of the campus, and the Montlake bridge, to the south of the university.

A latter day account recalled how their placement became "a political free-for-all." At one point a compromise plan was proposed, a $1,830,000 bond issue that would build nine bridges, and this was submitted before the voters in 1914. Charges that private interests such as real estate developers would benefit led the citizens to reject the referendum. On March 1915 voters ratified a new plan for building what became known as the Fremont, Ballard, and University bridges, all west of the site of the Montlake bridge.[7] The city built the Fremont and Ballard bridges in 1917,and the University or Eastlake Avenue bridge in 1919. Population growth and urban expansion, geography, and political debates determined the locations of Seattle's movable bridges. The City Bridge Engineering Department and a certain legal complication affected for their design.

In a 1920 *Engineering News-Record* article City Bridge Engineer F.A. Rapp described the first three bascule bridges. The basic design was based on double-leaf trunnion bascules developed by the Chicago Department of Public Works in 1898. Each of these three new bridges had half-through trusses with slanted or horizontal top chords and curved lower chords, live-load bearings in advance of the trunnions, heavy transverse girders supporting the trunnions, and concave racks. The transverse girders extended through the trusses of the movable leaves, a detail which would become an important legal issue. The racks were built into the heel end of each leaf truss and the counterweight was attached directly behind. Reduction gears and drive shafts were located to the sides of and behind the counterweights. These were driven by electric motors behind the counterweights. An electric motor, with the aid of reduction gears and levers, opened and closed plungers located in one leaf which fit into slots in the other.[8] The Montlake bridge, built later than these three bridges, is similar. It differs in that its roadway and sidewalk are supported by deck trusses and its trunnions bear on concrete brackets or corbels cantilevering from the piers rather than transverse girders.

The substitution of concrete brackets for the transverse girders used in the earlier Seattle bascule bridges was due to a development that neither the politicians nor bridge engineers could foresee. Rapp's article, published in 1920, caught the attention of the officers of the Strauss Bascule Bridge Company of Chicago, which had pioneered in bascule bridge design and had built more bascule bridges than any other company or engineering concern. The year after Rapp's article appeared in the *Engineering News-Record,* the company sued Seattle, alleging that the city had infringed on its patent rights in the construction of its bascule bridges. The lawsuit, brought before a federal court, sought to recover damages of $353,140.85, plus interest, a claim which the finance committee of the city council had previously rejected. The company also asked for a permanent injunction enjoining city officials from proceeding with any bascule bridge work under consideration.[9] Seattle decided to resist the suit brought against it and the corporation counsel asked that $20,000 be appropriated to enable the city engineer to gather evidence.[10]

The Strauss Bascule Bridge Company had already sued the City of Chicago, on similar grounds, filing suit on 11 March 1913. The issue was the same, the use of a cross girders to support the trunnions, which, according to the Strauss company, was an infringement its patent no. 995,813. The federal courts awarded the company damages totalling $348,500, on 19 November 1920.[11] The two cities were not the only defendants in such suits, for the Strauss company also brought suit against one of its competitors, the Scherzer Rolling Lift Bridge Company. The federal district court in Chicago dismissed the case in 1922.[12]

The Strauss Company initiated the suit against Seattle at a time when the city engineering department and the bascule bridge-building program were in trouble. On 12 July 1922, a headline in the *Seattle Post-Intelligencer* announced that "Huge Payroll in Dimock Department Shown." The author claimed that during the previous nine years the city engineering department had spent $2,255,000 on salaries but only $1,573,000 on the three canal bridges built to date, that although no bridges had been built for three years the "bridge department" continued to grow, and that the city had "paid out $6,000 to one Alexander Von Babo for certain bridge patents." The author probably meant patents granted to this individual on which the Chicago bascule bridge type was based.[13]

In addition, Dimmock reportedly had ignored offers by the Strauss Company to save the city $150,000 on the three canal bridges and $50,000 on the Spokane Street Bridge. In two years the bridge department had made fifty studies for the Spokane Street bascule bridge at a cost of $29,000. The *Seattle Post-Intelligencer* claimed that "...the Strauss Company would make its own plans at no additional expense to the city, and construct the bridges, relieving the taxpayers of the heavy burden of maintaining Dimmock's bridge department."

The *Post Intelligencer's* columnist portrayed City Engineer Arthur H. Dimmock as a poor administrator, unaware of the goings on in his own department, not knowing how many employees he had or where the money was being spent. As for the lawsuit, Dimmock was quoted as saying "Don't worry about the lawsuit. . . . That is the least of my troubles."[14]

An editorial in the same issue of the *Post-Intelligencer* concentrated on the lawsuit, calling for "sober counsel" and accusing the city of proceeding with the "Chicago plan of a double leaf bascule bridge" despite warnings of a lawsuit. The editorial questioned the wisdom of proceeding with the construction of Spokane River bridge, compounding the problem.[15] Not long after these issues became public, a new city administration removed Dimmock from office and replaced him with James DeRuyter Blackwell.[16]

If Strauss Bascule Bridge Company officers hoped to persuade the city government to abandon its version of the Chicago bascule bridge type and to instead have the company build bascule bridges for the city, they were disappointed. The Strauss company continued to press its litigation, with a brief pause when the suit was settled out of court in the fall of 1922. By the terms of the settlement, the company was to furnish the city with complete plans for the Spokane St. bridge. The city would pay the company $50,000, and an additional sum of $25,000 if the plans were adopted.[17]

This truce ended the following spring, when the Strauss Company sued the city for libel, demanding $100,000 because City Engineer Blackwell stated that, "The Strauss design is not equal to the city design and if it were made equal it would cost more than the city design." The company also sued the city for breach of contract, demanding $19,392.14, "as representing five-tenths of the savings which the company [alleged] would have resulted by the construction of a Strauss type bridge across the West Waterway at Spokane St., and which the city had agreed to pay the bridge concern."[18]

While this conflict continued, some citizens of Seattle grew impatient and began to call for construction of the Montlake bridge, whose foundation had been built in 1914 when the Lake Washington Ship Canal was dug. Only in America could football become a justification for building a bridge. The University of Washington stadium was built in 1920, just north of the Montlake cut, and graduate manager Darwin Meisnest constructed a pedestrian pontoon bridge across the canal for fans attending the first game in the new edifice, against Dartmouth. Meisnest campaigned for the permanent bridge, with a slogan and appeal to fair play, "You have your bridge, let us have one too." Throughout this crusade, the future structure was known as the "Montlake-Stadium bridge."[19]

The city bridge engineering department attempted to avoid further troubles with the Strauss Bascule Bridge Company by developing what they believed was not an infringement on Patent number 995,813. In the Montlake bridge, they employed concrete brackets rather than a transverse girder to support the trunnions.[20]

On 27 January 1924, the *Seattle Times* announced that "Engineer Completes Montlake-Stadium Bridge Plans" and that the contracts could be awarded once the voters re-approved a $550,000 bond issue. The author recounted a few details of the long process leading up to this moment. The piers had been built in 1914 at a cost of $40,000, of which $30,000 was from the county road fund and the rest from the federal government. Attempts to pass a bond issue had failed in 1914, 1919, and 1922. As for the design, the author wrote:

> Engineers have attempted in their design of the bridge to make it fitting architecturally to the building on the University campus. It will be the most imposing of the city's bridges, according to the plans, the situation of the

> bridge permitting ornamental designs not practical on spans in commercial sections. The two towers, which will top the reinforced concrete approaches, will be of Gothic design. The bridge span proper will be 182 feet in length and have a 68-foot approach at each end. The roadway will be forty feet wide with a twelve-foot walkway on each side.

A perspective sketch of the Montlake bridge accompanied the article, probably executed long before the plans were completed, because it depicted two towers at each end of the bridge rather than the arrangement of one tower at each end as in the final design.[21]

A few months later, the city called for bids on the project, to be submitted to the city engineering department by 27 June 1924.[22] The low bidders were C. L. Creelman, at $159,269 for the substructure, Wallace Equipment Co., at $160,452 for the superstructure, and Westinghouse Electrical and Manufacturing Company, at $26,133, for motors and gears. Each firm had offices in Seattle.[23]

Despite the substitution of concrete brackets for cross girder trunnion supports, the Strauss Company sued again and asked for an injunction to halt construction of the Montlake bridge. On 14 January 1925, the Federal District Court in the Western District of Washington refused to interfere, expressing "grave doubt if there was any infringement." The U.S. Circuit Court of Appeals at San Francisco upheld this decision, on 20 April 1925, sending the case back to the district court. It was never brought to trial and was finally dismissed on 7 May 1929, long after the Montlake Bridge was completed.

The Circuit Court of Appeals in San Francisco, when upholding the decision to refuse an injunction, based its decision on "certain material evidence" not presented before the court handing down the judgement against the City of Chicago in favor of the Strauss company in 1920. The City of Seattle argued that two very large precision beam-balance scales at the U.S. Mint in San Francisco, made in 1871, employed a principal identical to that of a cross-girder trunnion support. The central support for the beam in each scale consisted of a transverse support, a metal bar, extending through a circular opening in the beam. A transverse knife edge mounted within and at the top of the hole rested throughout its length upon the transverse support. This support, the defense argued, worked like a transverse girder extending through a bascule bridge leaf, in which a movable leaf is balanced on a the girder. As the scales predated Patent No. 995,813, the company could not claim that their invention was novel and unique, and the part of the patent covering the transverse girder was invalid.[24]

Eight years of litigation over this issue affected the Montlake Bridge's design. Of the six bascule bridges built during Seattle's bridge-building program from 1917 to 1930, it is the only one with concrete brackets supporting the trunnions instead of transverse girders.[25]

Eleven years after its foundations were built, and despite political battles and litigation that plagued Seattle's bascule bridge-building program, the Montlake bridge was ready for service in June 1925. It was dedicated with great ceremony on Saturday, 27 June 1925. Speakers, city officials, and community leaders stood on a platform at the east tower. Several thousand local residents crowded onto the bridge and its approaches. Mayor Edwin J. Brown served as motorman on the first street car to cross the bridge, which was freshly painted and decorated with bunting just for the occasion. At his side was D. W. Henderson, superintendent of the Railway Department, stood at his side. City Engineer J. D. Blackwell, the staff who designed the bridge, members of the city council, and other officials sat inside. Harry W. Carroll, city comptroller, served as conductor. The police band led the procession. Mrs. Henry Landes, president of the City Council, broke a bottle of what the newspaper account of this event called "effervescing fluid" on a bridge support to christen the structure.[26] Dedication committee chairman Darwin Meisnest, who had campaigned so vigorously for the "Montlake-Stadium bridge," introduced all who were involved in the project. Mayor Brown spoke of the bridge as an part of Seattle's long tradition of financing public improvements. He also praised the bridge designers, for their work. The Reverend Cleveland Kleihaer, a local minister, saw the bridge as a symbol of the greater unity of Seattle.[27]

Because of their importance to travel and their high visibility in an urban setting, Seattle's bridges have continued to be a controversial topic for public debate. This is especially true of the bascule bridges, since opening them for ships can delay traffic. The citizens of Seattle, however, have also considered them a source of civic pride and seem to be fascinated by them.

Federal law controls the construction and operation of bridges spanning navigable waterways, which have historical and legal precedence over the roads. The city cannot operate the bascule bridges without some restrictions imposed by the U.S. Coast Guard. This has resulted in a conflict of interests resulting from ever increasing numbers of automobiles create traffic jams and rush hours, unforeseen when the city built these bridges in the 1910s and 1920s.

As early as 1958 the *Seattle Times* printed a lengthy article with several full-page spreads of photographs depicting traffic backed up at important bridges, including the Montlake. It reported that according to City Engineer Roy W. Morse the five canal bridges, including the four bascules, were 38.7 percent overloaded.[28]

One columnist, in 1966, wrote that "on 17,003 occasions last year, Seattle motorists sat in their automobiles and pondered the fickleness of fate. The truly impatient ones may even have wished for a latter-day Sir Francis Drake to sink Seattle's Armada...it is only when the Montlake Bridge is opened just a few minutes before or after a Husky football game that Seattleites grow truly incensed by our draw spans." According to this writer, the Montlake bridge had opened 1,270 times during the previous year.[29] Fifteen years later, in 1981, the number of Montlake bridge openings would increase substantially, to 5,854.[30]

Should a bascule bridge fail, the problem is worse. On Friday, 7 May 1977, the Montlake bridge suffered its first serious breakdown which prevented the south leaf from opening. The span dropped 40', damaging the gear mechanisms. Engineers and city workers labored all night to "jerry-rig" the bridge, allowing the yachting season's opening day parade to pass underneath.[31] Traffic on the waterway was not to be held up. The Montlake bridge suffered another breakdown during rush hour on 26 August 1986, when a broken pinion gear left the bridge south leaf stuck in the raised position.[32]

In 1978 a public function involving vehicular and pedestrian traffic was allowed to impede boat traffic. The Seattle Engineering Department, with the Coast Guard's permission, closed the bridge to boat traffic 90 minutes before and after University of Washington football games.[33]

The problem has led to calls for action. In 1970, a journalist noted that two other Seattle bascules, the Spokane Street bridges over the Duwamish waterways, were being opened more often during rush-hour due to the increasing industrialization of the river. The article called upon the Coast Guard to "promptly accede to the City Council's request for a ban on Spokane Street Bridge openings during morning and evening rush hours."[34]

During that same year, Mayor Wes Uhlman proposed the construction of a second Montlake bridge or a tube under the canal to relieve congestion. He stated that the Montlake bridge was carrying more traffic than any other bridge its size in the United States.[35]

At times, public discussion of the problem turns into heated debate. In a 1981 issue of the *Seattle Times*, a professor of economics argued that the opening of drawbridges for yachts was inequitable, was costly, and was "generating what is called a negative consumption externality by imposing costs on innocent third parties, namely the drivers and passengers in 60-70 cars waiting in line to cross the bridge when it is lowered."[36]

Many readers were quick to respond with letters to the editor. Some agreed with the economist. Others claimed that he did not know all the facts, pointing out that commercial vessels used the canal as well as pleasure boats and that not all owners of sailboats were wealthy. One writer not only disagreed with the professor, but accused him of "academic elitism" by using terms most people could not understand. A tugboat skipper suggested that bridge tenders be provided with some sort of a device employing electric eyes to measure vessel heights, in advance of each bridge, to reduce the number of unnecessary bridge openings.[37]

In 1985 the Coast Guard ordered the city to open its bascule bridges "promptly and fully" for any vessel, no matter what the size. This was in response to complaints, including one by officers on a large vessel who claimed that one bridge-opening was so small they feared their craft would strike the structure.[38] In response to the subsequent public furor, a Coast Guard spokesman indicated that a June 1984 accident, when the Fremont Bridge closed too soon and damaged the tug boat Anna Foss, was another reason for the decision. This ruling particularly displeased Dr. Mickey Eisenberg, director of Emergency Medical Services at University Hospital located just to the northwest of Montlake bridge, who feared that the few extra minutes required for opening and closing the bridge could cause critical delays for ambulances.[39]

Seattle's bridges, especially the bascules, are objects of pride, admiration, and special interest. Some consider the Montlake bridge, the gateway to the University of Washington campus, to be the most beautiful bridge in the city. In 1972 Kurt Stampe, senior engineer in the bridge and maintenance section of the Engineering Department, stated in an interview that "The Montlake bridge is really beautiful. They don't build them like that anymore -- today you go to high level or tunnel."[40]

A more theoretical discussion regarding the issue of bridge aesthetics used the Montlake bridge as an example. A columnist in a 1966 *Seattle Post-Intelligencer* article argued that:

> Beauty is not inherent in the functional and technical solution of the purpose and there are local bridges that stand witness to this fact. . . . Unless an unusually creative engineer is the designer, engineers must work with architects to develop the appropriate concept and form. In

> the past, this has taken place in Seattle, when some of the bridges were built. The Montlake Bridge . . . is one of the more attractive bridges and this appears at least partially due to the involvement of three architects Edgar Blair, Harlan Thomas and A. H. Albertson working in an advisory capacity with the structural engineer.[41]

The bridge once became a historic preservation project. Bill Couch made the restoration of the lamps at the bridge his personal cause. When he was a University of Washington student and a bridge tender in 1969, he dreamed of someday repairing the lights. He did not realize his ambition until 10 years later, while working for the city engineering department, where he managed to use money and labor left over from other city projects to accomplish his goal.[42]

Newspapers have published articles about bridge tenders and their control towers. One such example included a group of photographs depicting the variety of "bridge tender offices" at operable bridges in Seattle, including the Montlake.[43] Another author wrote about the life of bridge tenders in an article entitled "Life in a Birdcage."[44]

The Montlake Bridge has been a significant part of Seattle's history. It was part of a the growing city's bascule bridge-building program during the 1910s and 1920s. Political debates determined the location of the six bascule bridges the city eventually built. The city engineering department and the Strauss Bascule Bridge Company's lawsuit determined the design. As a result, the Montlake Bridge is the only one in which the trunnions are supported by concrete brackets. The designers also took pains to make it compatible with the Gothic architecture of the nearby university, creating what many consider Seattle's most attractive bridge. Despite political controversies, defeated bond issues, and litigation, the Montlake bridge became an important part of Seattle's road system, a landmark, a never-ending topic for public debate, and a source of civic pride.

Design and Description

The Montlake Avenue Bridge, like the five other bascule bridges built by the city of Seattle during the 1910s and 1920s, is an adaptation of the "simple trunnion" bascule bridge type developed in the city of Chicago.[45] The type is distinguished by a leaf with counterweight at the heel of the truss, trunnions or pivot points located at approximate center of gravity of the leaf and counterweight, with the dead load entirely supported by the trunnions during operation and the live load supported by bearing shoes in front and below the trunnions. This bridge features a concave rack built into the truss, a feature common in the

Chicago type, invented by Frederick von Babo of Chicago and patented in 1910.[46]

The Montlake bridge is distinctive for several reasons. Like the five other bascule bridges built by the city of Seattle during the 1910s and 1920s, it is an example of the simple trunnion or Chicago bascule bridge type. The engineers developed a unique method for fastening the wooden deck to the superstructure in this bridge. Unlike the other bascule bridges built across the Union ship canal and the Duwamish River, it employs reinforced-concrete brackets or corbels to support its trunnions. These cantilever from piers designed to fit the foundations built during the construction of the Union ship canal in 1914 and to avoid constricting the channel. The piers are anchored into the embankment with a reinforced-concrete strut to prevent them from moving. The concave racks are built into the trusses, a feature covered by a patent granted to Alexander Von Babo in 1911. The bridge also features a specially designed center lock. Finally, the Montlake Bridge is also distinctive because of its architectural treatment, which was inspired by the Gothic architecture of the nearby university campus.

The drawings for the bridge survive, permitting a description and analysis of the structure. An article about the Montlake Bridge, appearing in a 1925 issue of *Engineering News Record,* provides additional information.

The Montlake Bridge consists of a double-leaf bascule with a span of 182′ between the trunnions or pivots at their centerlines and a 68′ long reinforced-concrete approach at either end. The clearance between the concrete frames supporting the leaves is approximately 150′, face to face. The vertical clearance under the leaves, from the center of the span to the water, is 48′[47]

The approaches are of reinforced-concrete, consisting of decks supported by beams on octagonal reinforced-concrete piers with flared capitals. The sidewalks and roadway are the same widths at the approaches as on the bascule span. The approach and the movable deck meet at a point that is 13′-1-5/8" behind the trunnion centerline. The columns bear on footings in the steep embankments. These embankments rise approximately 50′ above the canal to a point 79′ behind the trunnions and 95′ away from the canal's edge. The footings bear on piles consisting of 16" steel pipes filled with concrete. Spaces under the approaches, which house the machinery, are enclosed on either side with gunite curtain walls.

The *Engineering News-Record* article which discusses this bridge states that test borings found that there was a thin layer of fine sand mixed with some gravel below the water level of the canal, and that this material had a tendency to run during excavations. To avoid reducing the stability of the embankments, the engineers decided to support the load of the footings independently piling driven below this material.[48]

The deck, as originally built, was 60' wide with a 40'-wide roadway flanked by two 10'-wide sidewalks. The roadway consisted of 4" x 4" x 8" wood blocks on 4-1/2" x 9-1/2" wood stringers laid crosswise and face-to-face. The stringers were bevelled to create a crown and were supported by 3" x 10" wood joists laid longitudinally and face-to-face. All wood in the roadway was creosoted. The sidewalks consisted of 2" x 8" planks supported by 3" x 12" wood stringers laid longitudinally.[49] Rectangular steel trolley arches bear on the trusses below and still carry electrical wires, now used to power buses. The roadway joists and the sidewalk stringers were supported by 45 lb. I-beams laid crosswise.[50] The massive wooden roadway deck has been replaced with a steel grid.

The city engineers developed their own detail for securing the wood to the I-beams. This consisted of 2-1/2" x 6" x 1/4" galvanized iron plates nailed to the floor joists. These had notches fitting over the edges of the flanges of the beams.[51] This was a simple and elegant solution to the problem of securing a heavy wood deck to a supporting structure that would tilt up to 78 degrees.

The Seattle city engineering department eventually replaced the wooden sidewalk with concrete and the wooden deck with a steel grid. They did this after experimenting with steel grids at other bascule bridges. In 1931 the city installed a new, relatively light-weight floor on the West Spokane Street bridge consisting of steel mesh laid on galvanized sheet iron covering treated timber planks. The mesh was filled with asphalt.[52] The following year, they remodelled the University Avenue bridge with an open-mesh steel deck, providing it with more roadway capacity without strengthening the trusses.[53] The Montlake bridge received its steel mesh deck in 1946.[54] The *Engineering News-Record* regarded the University Avenue bridge retrofit as novel in 1933, but this material later became the standard floor for bascule bridges, supplanting wooden bridge decks, which were susceptible to fire, and extending the lives of bascule bridges in spite of increasing loads, by reducing the weight of the moving spans.

The I-beams supporting the deck lay crosswise on pairs of riveted steel trusses at their panel points. Each truss is of a Pratt configuration with diagonals in tension and verticals in compression, and with a curved bottom chord. The trusses are 44' apart, on center, with each pair of trusses connected to each other by a system of diagonal and horizontal bracing in the space between them. The sidewalk cantilevers beyond the trusses. The panel points are at 15'-5-1/4" on center, with five panels from the center lock to the live load bearing supports or pedestals. The trusses are 7' deep at the center of the span and 22'-6" at the pedestals. Behind the pedestals, the trusses framing into and around the trunnions. They also support a reinforced concrete counterweight at the heel each leaf.[55]

The approximate center of gravity for each leaf is located at the centerline of its trunnions, making it possible to move the leaf with a minimum of motive power. When the bridge opens the entire dead load of the leaf and counterweight is supported by the trunnions. When the bridge is closed, the leaf rests on the live load bearing plates, located in front of and below the trunnions, and a rear anchor lug, attached to the top of the counterweight, engages a seat above it. The seat is attached to the structure of the approaches. Under live loading the leaf acts like a cantilever supported at the bearing plates and anchored at the lugs. This arrangement for supporting the loads is fundamental feature of the simple trunnion or Chicago bascule bridge type.[56]

The pedestals are close to the canal. Each is located 13'-0-5/8" in front of the trunnions and at an elevation that is about 14' below the elevation of the trunnions.[57] In plan, the pedestals and the trunnions are centered on the four corners of a rectangle that is 44' long and 13'-0-1/8" wide.

The structure supporting these shoes and trunnions is a massive reinforced-concrete frame consisting of four piers joined by girders. The girder between the piers closest to the canal supports the two live load pedestals. Reinforced-concrete corbels or brackets extend from the tops of the other two piers, pointing towards each other. The trunnions rest on these corbels or brackets. The beam between these two higher piers is located at the bases of the piers, permitting the heel of the trusses and the counterweight to move over it. This frame rests on foundations that were constructed when the canal was dug, twelve years before the bridge was constructed.[58] The piers are braced by 134' long concrete struts, each containing 32 square inches of reinforcing steel, which extend to concrete anchors behind the embankment. These anchors were poured by means of a hole drilled down to them from the level ground above.[59]

As already explained, the concrete brackets or corbels supporting the trunnions was made necessary by the litigation which the Strauss Bascule Bridge Company brought against the city of Seattle, due to the use of the transverse girders in the earlier bascule bridges built by the city.[60] The *Engineering News-*

Record article concerning this bridge explains that the engineers decided to use the concrete struts to prevent any embankment slip, to prevent any change in the span length between the trunnions, and to maintain an even pressure on the foundation during operation of the bascule leaves and under live loading.[61]

The machinery moving the leaves is laid out on concrete decks behind and on either side of the counterweights, in the spaces below the approaches. Built into each truss, between the trunnion and the counterweight, is a concave rack with is 16' radius, measured from the trunnion centerline. The rack is driven by a gear or pinion that is 1' in diameter. The pinion is driven by a short shaft extending from a reduction gears-train just to the side of the rack. These gears are driven, in turn, by a steel shaft, approximately 5" in diameter, which extends back, in the direction of the embankment. At the end is a large gear which meshes with another gear. This second gear is on the end of another steel shaft, similar to the first shaft and perpendicular to it, which is driven by a differential at the centerline of the bridge and behind the counterweight. The sequence is identical on either side of the bridge centerline. Two electric motors power this drive train, with a gasoline-powered motor used in emergencies. The series of smaller gears meshing with larger ones provides the motors with the leverage necessary to move the great mass of the leaves and counterweights.[62]

As already indicated, a Seattle newspaper criticized the city government for paying royalties to Alexander Von Babo. This must have been for the use of the concave rack. Concave racks, built into the truss just in front of the counterweight, were covered by Patent 1,001,800, granted to Alexander Von Babo of Chicago in 1910.[63] The drawings for the Montlake bridge include a detail for a plate with this patent number and the date it was issued, but this plate was never fabricated and attached to the bridge.[64]

Two center locks prevent movement of the leaves when they are down. These are shear locks located at the lower chords of the trusses. Each consists of a horizontal key casting, a guide casting, and a jaw casting. The guide casting is attached to the south leaf and the jaw casting is attached to the north leaf. The key is 3" high x 5" wide, with 2" x 2" slides on each side. The key moves back and forth, with the slides fitting into grooves in the guide casting. When the locked position, the slides fit into grooves in the jaw casting.

A pitman moves the key. A motor with a high reduction gear train is located at the east truss of the south leaf and it drives the pitman at either lock, the west pitman directly, the other by means of a transverse shaft. In the event of a power failure, the bridge tender can disengage the motor from the gear train and use a hand crank to drive the locks.[65] The author of the *Engineering News-Record* article considered the centerlock, designed by J. A. Dunford of the city bridge engineering department, a novelty, perhaps because of the slides and grooves.[66]

The control system for all this machinery has features designed to assure the safety of its operation. Magnet-operated brakes at the motor shafts are spring-held in a closed position at all times except when the bridge tender opens them. Limit switches sense when a leaf or the center locks exceeds its paths of travel and shut off operation. The control panel is designed to prevent the tender from doing anything out of sequence. He or she must stand on two dead-man pedals while operating the bridge. Failure to do so will cause the motors to halt and the brakes to close.

The Montlake Bridge was designed to complement the architecture of the nearby university and as such is ornamented in the Gothic style. At the ends of the walls flanking the approaches to the bridge are posts shaped like finials with pointed tops. Street lamps flank the approach and have a vaguely Gothic appearance. The verticals in the railings along the sidewalks on the span are in the form of pointed arch windows with quatra-foil openings below, which is the reverse of Medieval practice. On the walls enclosing the machinery and counter-weights are buttresses, flattened Tudor arches, eyebrows over the double access doors, and single doors with pointed headers.

The two towers, of which only the southern one is used, are the most noticeable part of this structure. These are located at the northwest and southeast corners of the bascule span. The upper portions, at the level of the control room, are clad with terra cotta with intricate detailing. The attic above has art-glass windows and the whole is roofed with copper sheeting with ribbing and topped with a cupola.

Much of this is illusory. The finials are of "precast stone." The walls enclosing the machinery are not poured concrete, but are 3-1/2" thick curtain walls consisting of gunite on wire mesh over steel angles. The railings along the approach are of brick panels inset in gunite, as well as the lower portions of the towers, where this finish is backed by hollow tile.[67]

Whether this may be regarded as beautiful is a matter of perspective. Any person who accepts the aesthetic theory that an efficient technological solution to a functional problem is inevitably a beautiful one, and that structure should never be disguised, will probably not find this bridge very appealing. On the other hand, the viewer might consider this bridge beautiful if he or she considers it proper to clad a structure with an ornament derived from historical prototypes or in response to a context, even to the extent of disguising structure or mechanical workings, that individual might consider this bridge . Whatever the case, the architectural treatment of the Montlake bridge is part of its uniqueness, along with its structural and mechanical details.

Repair and Maintenance

The Montlake bridge has had the sort of maintenance problems that many steel and reinforced concrete bridges suffer from, such as cracking and spalling concrete, pavements worn down to the aggregate, and rusting structural members. The bridge has been completely repainted every 10 years, on the average. Pigeons build their nests and leave guano on the structure.

There have been certain alterations and repairs that can only be done to bascule bridges. The steel grid deck, which replaced the wood roadway deck, sometimes comes loose from the supporting structure and maintenance crews have to weld it back down. The bridge has also been improved in other ways over the years, including the replacement of the windows around the bridge tender's room, in 1963, and the installation of a rectifier to transform alternating current into direct current for the motors, in 1965. The machinery moving the leaves in this bridge requires constant attention. On 6 May 1977 the bridge had been opened to full open too quickly and the impact of the leaf against the upper bumper blocks put too much stress on the pinion. The south leaf of the bridge fell 10 degrees. This was due to the failure of a bearing cap bolt in the west pinion, which also resulted in severe damage to the west reduction gear train, with some of its gears literally being thrown out of place.

On 25 August 1986, a tooth broke loose from one of the pinion gears, causing severe damage to a drive train and leaving the south leaf jammed in the open position.

On 6 January 1990, the west pinion of the north span lost a tooth and became lodged in the rack. As the other pinion teeth went over the fractured tooth, it deformed part of the rack and sheared off two of its mounting bolts.[68]

Data Limitations

There was no lack of information for this bridge, which is not surprising, considering its site and visibility. Sources of information included newspaper articles gathered by the Washington State Library in Olympia, the Seattle Public Library, the Washington State Historical Society Library in Tacoma, the Special Collections at the University of Washington Library, and the Seattle Historical Society Library at the Museum of History and Industry. Several articles in the *Engineering News-Record* dealt with this bridge, the other Seattle bascule bridges, and the litigation brought against Seattle by the Strauss Bascule Bridge Company. Blueprints of the drawings for this bridge, available at the Washington State Department of Transportation's Bridge Condition Unit in Olympia, which facilitated analysis of the structure. Seattle Bridge Tender Douglas Russell was kind enough to take HAER architects Karl W. Stumpf and Catherine I. Kudlik, and historian Wm. Michael Lawrence through all parts of the bridge and answer questions. A visit to the City of Seattle Engineering Department might have provided more specific details concerning the history, design, construction, and maintenance of the bridge, but time constraints did not permit it.

<u>Project Information</u>

This project is part of the Historic American Engineering Record (HAER), National Park Service. It is a long-range program to document historically significant engineering and industrial works in the United States. The Washington State Historic Bridges Recording Project was co-sponsored in 1993 by HAER, the Washington State Department of Transportation (WSDOT), and the Washington State Office of Archeology & Historic Preservation. Fieldwork, measured drawings, historical reports, and photographs were prepared under the general direction of Robert J. Kapsch, Ph.D., Chief, HABS/HAER; Eric N. DeLony, Chief and Principal Architect, HAER; and Dean Herrin, Ph.D., HAER Staff Historian.

The recording team consisted of Karl W. Stumpf, Supervisory Architect (University of Illinois at Urbana-Champaign); Robert W. Hadlow, Ph.D., Supervisory Historian (Washington State University); Vivian Chi (University of Maryland); Erin M. Doherty (Miami University), Catherine I. Kudlik (The Catholic University of America), and Wolfgang G. Mayr (U.S./International Council on Monuments and Sites/Technical University of Vienna), Architectural Technicians; Jonathan Clarke (ICOMOS/Ironbridge Institute, England) and Wm. Michael Lawrence (University of Illinois at Urbana-Champaign), Historians; and Jet Lowe (Washington, D.C.), HAER Photographer.

APPENDIX

<u>Bascule bridges designed and built by the City of Seattle during the 1910s and 1920s.</u>

Bridges built over the Union or Lake Washington Ship Canal:

Fremont bridge: built 1917, 242 foot trunnion span, with transverse girder trunnion support.

Ballard bridge: built 1917, 218 foot trunnion span, with transverse girder trunnion support.

University bridge: built 1919, 218 foot trunnion span, with transverse girder trunnion support.

Montlake bridge: built 1925, 182 foot trunnion span, with concrete bracket trunnion supports.

Bridges over the Duwamish River:

Spokane St. No. 1: built 1924, 288 foot trunnion span, with longitudinal girder trunnion supports.

Spokane St. No. 2: built 1929 - 30, 288 foot trunnion span, with transverse girder trunnion support.

(Source: "Eight Years of Litigation Over Seattle Bascule Bridges: Harried by Patent Suits, City Develops Non-infringing Design -- Basic Patent Appears Invalid After All." *Engineering News-Record* (19 December 1929): 969.)

SELECTED BIBLIOGRAPHY

City of Seattle, "Double Leaf Trunnion Bascule Bridge Over Lake Washington Ship Canal on Montlake Boulevard" (1923-25). Blueprints at the Washington State Department of Transportation's Bridge Preservation Section, Olympia, WA.

History of King County, Washington Vol. 3. Chicago and Seattle: The S.J. Clarke Publishing Company, 1929.

McCullough, Conde B. "Designs and Types of Bascule Bridges," in George A. Hool and W. S. Kinne, eds, *Movable and Long-Span Steel Bridges*. New York: McGraw-Hill Book Co., 1923, 1-38.

[Lisa Soderberg] "HAER/Washington State Bridge Inventory -- Montlake bridge," held by Washington State Office of Archeology and Historic Preservation, Olympia, WA [1980].

Professional journals:

"Bascule Bridge Litigation Settled." *Engineering News-Record* 89 (5 October 1922): 585.

"Chicago Settles with Strauss for Infringing Bridge Patent." *Engineering News-Record* 85 (9 December 1920): 1158.

"Double-leaf Bascule bridge over Canal at Seattle: New Form of Trunnion Support--Bridge Designed for 12-year Old Foundations--Anchored Against Sliding--Novel Center Lock." *Engineering News-Record* 95 (19 November 1925): 826-29.

"From Job and Office, For Contractor and Engineer: Metal Clips Fasten Floor Joists to Stringers in Lift Span." *Engineering News-Record* 95 (12 November 1925): 811.

"Eight Years of Litigation Over Seattle Bascule Bridges: Harried by Patent Suits, City Develops Non-infringing Design--Basic Patent Appears Invalid After All." *Engineering News-Record* 103 (19 December 1929): 968-69.

"Mayor of Seattle Removes City Engineer Dimmock." *Engineering News-Record* 89 (10 August 1922): 248.

"Open-Mesh Steel Deck for Seattle Bascule." *Engineering News-Record* 109 (24 November 1932): 624.

Price, P. L. "Steel Mesh Filled With Asphalt for Light-Weight Bridge Deck--Construction provides smooth non-skid surface and weight economy for Seattle bascule span." *Engineering News-Record* 107 (10 September 1931): 419.

Rapp, F. A. "Three Double-Leaf Bascule Bridges at Seattle Wash.--Spans Have Live-Load Bearings Beyond the Trunnions--Main Pinions Engage Concave Racks -- Trusses Assembled Short--Erected in Horizontal Position." *Engineering News-Record* 84 (8 April 1920): 718-722.

"Seattle Will Resist Bascule Bridge Suit." *Engineering News-Record* 88 (8 June 1922): 972.

"Strauss Bascule Bridge Co. Sues City of Seattle." *Engineering News-Record* 90 (31 May 1923): 976.

"Strauss Sues Seattle for Infringing Bascule Bridge Patent" *Engineering News-Record* 87 (8 September 1921): 421.

Newspapers--early history:

Armstrong, Hal. "Huge Payroll in Dimmock Department Shown--Nine-Year Salaries Total $ 2,255,000 While Three Bridges Cost $ 1,573,00--$350,000 Patent Infringement Suit 'Least of My Troubles' Declares City Engineer When Questioned About Conduct of Office." *Seattle Post-Intelligencer*, 12 July 1922, II-1.

"City Faces a Million Loss." *Seattle Post-Intelligencer*, 12 July 1922, II-18 [editorial].

"Construction News of the Pacific Northwest," *Pacific Builder and Engineer* 30 (17 May 1924): 14.

"Construction News of the Pacific Northwest," *Pacific Builder and Engineer* 30 (5 July 1924): 13.

"Council Votes Two Crossings For Waterways--Six Bridge Locations Picked on Canal--To Ask Government for Permits--Lobbyists At Meeting--Question of Subways Is Eliminated From Discussion--Griffiths Attempts to Have Entire Matter Delayed for Referendum." *Seattle Post-Intelligencer*, 26 February 1913, 20.

Dorpat, Paul. "Now And Then: Fair Play--Fans played a big part in spanning the cut." *Seattle Times/Seattle Post Intelligencer*, 13 November 1988.

"Engineer Completes Montlake-Stadium Bridge Plans--Contract Awaits Voters' Approval of $ 550,000 Bond Issue--Work Progresses on West Spokane Street Structure and Noise of Riveters to Be Heard in Short Time." *Seattle Times*, 27 January 1924, 8.

Kittenbon, C.B. "Bridge Desired For University--Rival Merits of Sixth and Tenth Avenues Are Discussed--HIGH SPAN ADVOCATED--Declared to Possess Advantage in that Less Disturbance of Traffic Is Involved." *Seattle Post-Intelligencer*, 30 November 1913, 9.

"Montlake Bridge, Seattle's Latest Viaduct, Is Dedicated--Mayor, City Officials, Engineers, and Others Take Part in Ceremony." *Seattle Daily Times*, 28 June 1925, B-1.

Warren, James. "Looking Back: Links To Seattle's Growth--When a ship canal cut a city in two, placement of bridges became a hot issue." *Post-Intelligencer/Northwest Magazine*, 15 February 1981, 14.

"Work on Canal Bridges Ordered--City Council Contemplates a Vote on Bond Issue to Raise Funds--Planks For Leary Ave.--Purposes to Take $ 18,500 From the General Fund for this Purpose." *Seattle Post-Intelligencer*, 28 October 1913, 18.

Newspaper--post-construction history:

"Bridges Can Be Wonderful." *Northwest Today*, 9. Supplement to *Seattle Post-Intelligencer*, 6 February 1966.

Broom, Jack. "Faithful span sprung: Who broke the Montlake Bridge." *Seattle Times*, 11 May 1977, E-11.

________. "It took all night, but the bridge crew did it." *Seattle Times*, 8 May 1977, A-1.

Cleaver, Dick. "Bridge-opening order expected to jam up traffic--The bridge must be opened 90 degrees straight up regardless of how small the boat may be." *Seattle Times*, 4 August 1985.

Dugavich, Bill C. "New Montlake Bridge lamps retain 'old' look--Man finishes project conceived in 1969." *The Seattle Times*, 30 January 1979, B-3.

Duncan, Don. "Boats, Autos Compete at Drawbridges." *Seattle Times* [?], 9 November 1966, 3. From Washington State Library bridge newspaper clipping file.

"Jammed Bridge Takes the Rush Out of Rush Hour." *Seattle Post-Intelligencer*, 26 August 1986, A-1.

Johnson, Dudley W. "Boaters should help pay." *Seattle Times*, 31 August 1981, A-11.

Kernmayr, Janice. "City of Bridges--We Have Them In All Sizes, Types, Designs--How Many Bridges? Who Knows?" *Seattle Times*, 14 May 1961, supplement, 21-26.

"Last Step in Montlake Bridge Job--Montlake Bridge Readied for Grid Game." *Seattle Post-Intelligencer*, 26 September 1946.

"Loneliness of a Long-Distance Bridge Tender Is the Toughest--Life in a Birdcage." *Seattle Post-Intelligencer*, 2 October 1977, A-20.

"Montlake Bridge schedule set for U.W.-game traffic." *Seattle Times*, 2 September 1978, B-5.

"Montlake Span is Ready for Football Crowd." *Seattle Times*, 27 September 1946.

O'Ryan, John. "Coast Guard's signal to Seattle: You'd better get your bridges up." *Seattle Post-Intelligencer*, 7 September 1985, A-2.

"Our Overloaded Bridges." Supplement to the *Seattle Times*, 12 January 1958.

"Seattle draw spans have their ups and downs." *Seattle Times*, 26 November 1982, B-4.

Suffia, David. "Ullman stresses need for 2nd Montlake bridge." *Seattle Times*, 13 August 1970, A-15.

Webber, Janet. "Bridge Tender 'Offices.'" *Seattle Times*, 15 December 1963, 20.

"West Seattle's Marooned Motorists." *Seattle Times*, 5 April 1970, A-12.

Whitely, Peyton. "Bridges: Hundreds of 'em and they're costly." *Seattle Times*, 28 March 1972, A-6.

ENDNOTES

[1] Janice Kernmayr, "City of Bridges--We Have Them In All Sizes, Types, Designs--How Many Bridges? Who Knows?" *Seattle Times,* 14 May 1961, supplement, 21-4. The number of bridges has undoubtedly grown appreciably since this article was published.

[2] *History of King County, Washington*, vol. 3 (Chicago and Seattle: The S.J. Clarke Publishing Company, 1929), 382-94; James Warren, "Looking Back: Links To Seattle's Growth--When a ship canal cut a city in two, placement of bridges became a hot issue," *Seattle Post-Intelligencer/Northwest Magazine*, 15 February 1981, 14. James Warren was the director of the Museum of History and Industry in Seattle at the time he wrote this article.

[3] "Council Votes Two Crossings For Waterways--Six Bridge Locations Picked on Canal--To Ask Government for Permits--Lobbyists At Meeting -- Question of Subways Is Eliminated From Discussion--Griffiths Attempts to Have Entire Matter Delayed for Referendum," *Seattle Post-Intelligencer*, 26 February 1913, 20.

[4] "Work on Canal Bridges Ordered--City Council Contemplates a Vote on Bond Issue to Raise Funds--Planks For Leary Ave.--Purposes to Take $ 18,500 From the General Fund for this Purpose," *Seattle Post- Intelligencer*, 28 October 1913, 18.

[5] "Double-leaf Bascule bridge over Canal at Seattle: New Form of Trunnion Support--Bridge Designed for 12-year Old Foundations--Anchored Against Sliding--Novel Center Lock," *Engineering News-Record* 95 (19 November 1925): 826.

[6] C. B. Kittenbon, "Bridge Desired For University--Rival Merits of Sixth and Tenth Avenues Are Discussed--HIGH SPAN ADVOCATED--Declared to Possess Advantage in that Less Disturbance of Traffic Is Involved," *Seattle Post-Intelligencer*, 30 November 1913, 9.

[7] Warren.

[8] F. A. Rapp, "Three Double-Leaf Bascule Bridges at Seattle Wash. --Spans Have Live-Load Bearings Beyond the Trunnions--Main Pinions Engage Concave Racks--Trusses Assembled Shoe--Erected in

Horizontal Position." *Engineering News-Record* 84 (8 April 1920): 718-22. According to Rapp the Chicago bascule bridge type serving as a model for the Seattle bascule bridges were described in *Engineering News*, 31 January 1901, 76, and 19 January 1905, 65.

[9] "Strauss Sues Seattle for Infringing Bascule Bridge Patent." *Engineering News-Record* 87 (8 September 1921): 421.

[10] "Seattle Will Resist Bascule Bridge Suit," *Engineering News-Record* 88 (8 June 1922): 972.

[11] "Bridge Patent Suit Settled," *Engineering News-Record* 85 (14 October 1920): 769; "Chicago Settles with Strauss for Infringing Bridge Patent," *Engineering News-Record* 85 (9 December 1920): 1158.

[12] "Decision in Bascule Bridge Suit," *Engineering News-Record* 89 (27 July 1922): 163.

[13] One variation of the Chicago bascule bridge type was based on Patent No. 1,001,800, granted to Alexander Von Babo in 1911. See Conde B. McCullough, "Designs and Types of Bascule Bridges," in George A. Hool and W. S. Kinne, eds, *Movable and Long-Span Steel Bridges* (New York: McGraw-Hill Book Co., 1923), 23.

[14] Hal Armstrong, "Huge Payroll in Dimmock Department Shown -- Nine-Year Salaries Total $2,255,000 While Three Bridges Cost $1,573,000 -- $ 350,000 Patent Infringement Suit 'Least of My Troubles' Declares City Engineer When Questioned About Conduct of Office," *Seattle Post-Intelligencer*, 12 July 1922, II-1.

[15] "City Faces a Million Loss," *Seattle Post-Intelligencer*, 12 July 1922, II-18 [editorial].

[16] "Mayor of Seattle Removes City Engineer Dimmock," *Engineering News-Record* 89 (10 August 1922): 248.

[17] "Bascule Bridge Litigation Settled," *Engineering News-Record* 89 (5 October 1922): 585.

[18] "Strauss Bascule Bridge Co. Sues City of Seattle," *Engineering News-Record* 90 (31 May 1923): 976.

[19] This anecdote is related in Paul Dorpat, "Now And Then: Fair Play--Fans played a big part in spanning the cut," *Seattle Times/Seattle Post Intelligencer*, 13 November 1988.

[20] "Eight Years of Litigation Over Seattle Bascule Bridges: Harried by Patent Suits, City Develops Non-infringing Design--Basic Patent Appears Invalid After All," *Engineering News-Record*, 19 December 1929): 968.

[21] The bond issue had already been approved the previous year, but was again made a ballot item to comply with a new state law governing bond issues. "Engineer Completes Montlake-Stadium Bridge Plans--Contract Awaits Voters' Approval of $550,000 Bond Issue--Work Progresses on West Spokane Street Structure and Noise of Riveters to Be Heard in Short Time," *Seattle Times*, 27 January 1924, 8; not mentioned in this article were three architects, Edgar Blair, Harlan Thomas, and A. H. Albertson, who served in an advisory capacity for the engineers. These architects shared some of the responsibility for the architectural treatment of the structure; "Bridges Can Be Wonderful," *Northwest Today*, 9, supplement to *Seattle Post-Intelligencer,* 16 February 1966.

[22] "Construction News of the Pacific Northwest," *Pacific Builder and Engineer* 30 (17 May 1924): 14.

[23] "Construction News of the Pacific Northwest," *Pacific Builder and Engineer* 30 (5 June 1924): 13.

[24] "Eight Years of Litigation Over Seattle Bascule Bridges," 969.

[25] The west Spokane Street bridge, built during this crisis, employed longitudinal girders, presumably to avoid infringing on patent no. 995,813. See Appendix for a description of the bascule bridges built by Seattle along with the Montlake bridge.

[26] As this was during Prohibition, the fluid may have been non-alcoholic. Or if it was champagne, this was not admitted openly.

[27] "Montlake Bridge, Seattle's Latest Viaduct, Is Dedicated--Mayor, City Officials, Engineers and Others Take Part in Ceremony--Mrs. Henry Landes, President of Council, Christens Structure at Interesting Exercises," *Seattle Times*, 28 June 1925, B-1. The working drawings for the Montlake bridge includes a drawing for a bronze plate, to be hung at the bridge, with the following information regarding the designers and contractors for the bridge. The design and construction was by D.W. McMorris, Assistant City Engineer; A. Munster, Acting Bridge Engineer; J.A. Dunford, Superintendent of Construction. The advisory architects were Edgar Blair, Harlan Thomas and A.H. Albertson. Contractors for the project were C. L. Creelman, substructure, Wallace Equipment Company, superstructure, and Westinghouse Electric and Manufacturing Company, electrical equipment. J. D. Blackwell was City Engineer at the time and W.H. Tiedeman was Assistant City Engineer. D. W. McMorris, the senior member of the design team, was prominent enough in Seattle to have a biography in the *History of King County, Washington*, vol. 3 (Chicago and Seattle: The S.J. Clarke Publishing Company, 1929), 898-903. According to this source, he had supervision of bridge construction, operation, and maintenance since 1923 at the time of this publication.

[28] "Our Overloaded Bridges," supplement to the *Seattle Times*, 12 January 1958, 4.

[29] Don Duncan, "Boats, Autos Compete at Drawbridges." *Seattle Times* [?], 9 November 1966, 3. A cartoon depicting motorists cursing a ship's crew during a bridge opening accompanies this article.

[30] "Seattle draw spans have their ups and downs," *Seattle Times*, 26 November 1982, B-4.

[31] Jack Broom, "It took all night, but the bridge crew did it," *Seattle Times*, 8 May 1977, A-1.

[32] "Jammed Bridge Takes the Rush Out of Rush Hour," *Seattle* ,•x*Post-Intelligencer*, 26 August 1986, A-1.

[33] "Montlake Bridge schedule set for U.W-game traffic," *Seattle Times*, 2 September 1978.

[34] "West Seattle's Marooned Motorists," *Seattle Times*, 5 April 1970, A-12. A cartoon accompanies this article as well, depicting angry vehicle drivers heaping epithets at an ocean-going vessel, whose captain laconically says to a subordinate, "Gives you an awesome sense of power, doesn't it."

[35] David Suffia, "Ullman stresses need for 2nd Montlake bridge." *Seattle Times*, 13 August 1970, A-15.

[36] Dudley W. Johnson, "Boaters should help pay," *Seattle Times*, 31 August 1981.

[37] "Letters - Issues -- Should we tax the bridge-opening boats? Good grief!" *Seattle Times,* 6 September 1981, A-19.

[38] John O'Ryan, "Coast Guard's signal to Seattle: You'd better get your bridges up," *Seattle Post-Intelligencer*, 7 September 1985, A-2.

[39] Dick Cleaverl, "Bridge-opening order expected to jam up traffic--The bridge must be opened 90 degrees straight up regardless of how small the boat may be," *Seattle Times*, 4 August 1985.

[40] Peyton Whitely, "Bridges: Hundreds of 'em and they're costly," *Seattle Times*, 28 March 1972, A-6.

[41] "Bridges Can Be Wonderful," *Northwest Today*, 9, supplement to *Seattle Post-Intelligencer*, 6 February 1966.

[42] Bill C. Dugavich, "New Montlake Bridge lamps retain 'old' look --Man finishes project conceived in 1969," *Seattle Times*, 30 January 1979, B-3.

[43] Janet Webber, "Bridge Tender 'Offices,'" *Seattle Times,* 15 December 1963, 20.

[44] "Loneliness of a Long-Distance Bridge Tender Is the Toughest -- Life in a Birdcage," *Seattle Post-Intelligencer*, 2 October 1977, A-20.

[45] C. B. McCullough and Philip A. Franklin, "Bascule Bridges," in George A; Hool and W. S. Kinne, eds., *Movable and Long-Span Steel Bridges* (New York: McGraw-Hill Book Co., 1923), 1-39.

[46] Patent No. 1,001,800 (29 August 1911). The drawing for the Montlake bridge include a drawing for a plate with this patent number and date.

[47] City of Seattle, "Double Leaf Trunnion Bascule Bridge Over Lake Washington Ship Canal on Montlake Boulevard." [1923-25] Copy at the Washington State Department of Transportation's Bridge Preservation Section, Olympia, WA, Sheet A and 1.

[48] "Double-leaf Bascule bridge over Canal at Seattle: New Form of Trunnion Support--New Form of Trunnion Support--Bridge Designed for 12-year Old Foundations--Anchored Against Sliding--Novel Center Lock," *Engineering News-Record* 95 (19 November 1925): 826."

[49] City of Seattle, sheet 1.

[50] "From Job and Office, For Contractor and Engineer: Metal Clips Fasten Floor Joists to Stringers in Lift Span,"*Engineering News-Record*, 12 November 1925, 811.

[51] Ibid.

[52] P. L. Price, "Steel Mesh Filled With Asphalt for Light-Weight Bridge Deck--Construction provides smooth non-skid surface and weight economy for Seattle bascule span," *Engineering News-Record* 107 (10 September 1931): 419.

[53] "Open-Mesh Steel Deck for Seattle Bascule," *Engineering News-Record* 109 (24 November 1932): 624.

[54] "Montlake Bridge Readied for Grid Game," *Seattle Post-Intelligencer*, 26 September 1946; "Montlake Span is Ready for Football Crowd," *Seattle Times*, 27 September 1946.

[55] City of Seattle, sheets 1, 3, and 4.

[56] C. B. McCullough, "Designs and Types of Bascule Bridges," 20-21.

[57] City of Seattle, sheet 1.

[58] Ibid., sheet 53; see also, figure 3 in "Double-Leaf Bascule Bridge Over Canal in Seattle."

[59] City of Seattle, sheet 1.

[60] When the Spokane Street bridges were built at later dates, they did not employ this device, but reverted the transverse girders. See table in "Eight Years of Litigation Over Seattle Bascule Bridges: Harried by Patent Suits, City Develops Non-infringing Design--Basic Patent Appears Invalid After All," *Engineering News-Record*, 19 December 1929, 969.

[61] City of Seattle, sheet 1; figure 1 in "Double-Leaf Bascule Bridge Over Canal in Seattle."

[62] City of Seattle, sheets 1, 5, and M-1. See also, "Double-Leaf Bascule Bridge Over Canal in Seattle," figure 4; the motors are powered by direct current (DC), which can regulate the speed of the motors more effectively than alternating current. A rectifier, added since the bridge was built, transforms alternating current into direct current.

[63] McCullough, "Designs and Types of Bascule Bridges," 23.

[64] City of Seattle, sheet no. [?]]; the plate would have read "Patented, U.S. Letters Patent 1,001,800, Aug. 29, 1911."

[65] City of Seattle, sheets M-8 to M-9, and M-20. See also, "Double-Leaf Bascule Bridge Over Canal at Seattle," figure 4.

[66] "Double-Leaf Bascule bridge over Canal at Seattle," 829.

[67] City of Seattle, sheets 60 and 71-73.

[68] "Montlake Avenue Bridge," Kardex Card File; and "Bridge Inspections in "Movable Bridges Files," at Bridge Preservation Section, Washington State Department of Transportation, Olympia, WA.